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नदी घाटी परियोजनाओं के निर्माण,  
प्रचालन और रखरखाव के लिए  
सुरक्षा संहिता

भाग 5 विद्युतीय पहलू  
( पहला पुनरीक्षण )

**Safety Code for Construction,  
Operation and Maintenance of  
River Valley Projects**

Part 5 Electrical Aspects  
( *First Revision* )

ICS 93.160

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## FOREWORD

This Indian Standard (Part 5) (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Safety in Construction, Operation and Maintenance of River Valley Projects Sectional Committee had been approved by the Water Resources Division Council.

With large scale increase in construction activity of river valleys projects, the number of major accidents has been increased. The degree of safety achieved in project construction has a direct bearing on the amount of effort expended to avoid accidents by those who control the conditions and practices on the project.

There are number of aspects that need to be kept in mind when the safety norms of an entire river valley project are envisaged. To this end, various aspects that need consideration, from the viewpoint of safety, are dealt with in various parts of this standard.

This Part covers the safety aspects to be kept in view during work on or around electrical installations and those electrical aspects that are to be kept in mind from the view point of safety as well.

The guidelines given in this standard are generalized and indicative in nature, given for the guidance of the concerned project engineers. Each project may have its own safety hazards which need to be identified and taken care of accordingly. Further, in addition to those general guidelines the instructions issued by the suppliers of various equipment should be strictly adhered to.

All electrical installations should, however, be designed so as to conform to the requirements of the *Central Electricity Authority (Measures Relating to Safety and Electric Supply) Regulations*, 2010. The model code for safe operation and maintenance of generating stations and the manual on layout of sub-stations of the Central Electricity Board. The requirements of codes prepared by local electricity boards and any other reports issued by the Ministry of Energy as well as other statutory requirements should also be adhered to. The requirements given in this standard are a supplement to these.

This standard was first published in 1992. In this revision, new clauses for instrument transformers, gas insulated switch gear, cables, metal clad switch gear and preventive measures during work inside underground structures, general safety precautions, precautions during oil and SF<sub>6</sub> handling, splicing de-energized conductors have been incorporated in the standard.

The composition of the Committee responsible for the formulation of this standard is given at Annex B.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (revised)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

## *Indian Standard*

# SAFETY CODE FOR CONSTRUCTION, OPERATION AND MAINTENANCE OF RIVER VALLEY PROJECTS

## PART 5 ELECTRICAL ASPECTS

### *( First Revision )*

#### **1 SCOPE**

This standard (Part 5) lays down the safety requirements covering indoor/outdoor electrical installations of generating stations, tunnels, electrical stores, pumping stations, including generators, breakers, isolators, transformers, current transformers, potential transformers, instrument transformers, gas insulated switch gear, cables, metal clad switch gear, lightning arrestors, motors, storage batteries, illumination systems, pumps, cranes and hoists, etc.

#### **2 REFERENCES**

The following standards contain provisions which, through reference in this text constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on these standards are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

<i>IS No.</i>	<i>Title</i>
2190 : 1992	Selection, installation and maintenance of first-aid fire extinguishers — Code of practice ( <i>third revision</i> )
3716 : 1978	Application guide for insulation coordination ( <i>first revision</i> )
9668 : 1990	Provision and maintenance of water supplies for fire fighting — Code of practice ( <i>first revision</i> )
10386 (Part 7) : 1993	Construction, operation and maintenance of river valley projects valley — Safety code : Part 7 Fire safety aspects
13039 : 1991	External hydrant systems — Provision and maintenance — Code of practice

#### **3 PREVENTION OF ACCIDENTAL CONTACT**

All exposed electrical installations either because of location or otherwise should be so guarded that dangerous contact by persons shall not be possible.

Step bolts on structural steel tower columns should be placed such that their use shall not bring a person into the vicinity of electrical conductors, transformers or switch boxes that may be installed on the face of a tower, adjacent to the step bolts. Sufficient clearance should be provided in the design of substations, switchyards and transformer yards so that vehicles moving around and about high voltage equipment will not come in contact with equipment and damage it, or endanger themselves. Necessary provisions should also be made for stopping stray animals and cattle from coming into the vicinity of electrical installations.

#### **4 GROUNDING**

All non-current carrying parts/structures, materials, electrical appliances, tools, equipment, conduits, transformer enclosures, etc, should be effectively grounded. Parts of structures which might be expected to collect high static charge, such as towers and outlet pipes, should likewise be grounded. As a special precaution against accumulation of static charge on metals, floors and equipment in oil-storage rooms, or where explosive gases are to be used or may accumulate, these should be grounded. The power outlets and switches in these rooms should be fully enclosed in spark/explosion-proof chambers as far as practicable. All exposed switches and all other exposed and energized electrical installations should be so located as to avoid the possibility of simultaneous contact with them and with pipes, plumbing, or other connections to the ground. Manually operated remote-controlled disconnect-switch handles should be pigtailed to the grounded structure. The grounding of all electrical equipment should conform to relevant Indian Standards. Design of the grounding materials/electrodes should be done so as to limit the step and touch potentials within safety limits.

#### **5 DE-ENERGIZING POWER LINES**

**5.1** Provision should be made for de-energizing power lines and other installations and also grounding the same when maintenance and repair work is to be done, except where it is contemplated that hot-line tools are

to be used. Keys of locks, electrical interlocks on all chambers, cubicles or switchgear should be retained with senior authorized persons and other keys with the operator on duty or the person in charge of the concerned working party.

**5.2** Proper clearance procedure of obtaining permit to work on various electrical installations as given in 'The model code for safe operation and maintenance of generating stations' of Central Electrical Board should be followed.

## **6 SUB-STATIONS**

**6.1** Minimum and sectional clearances as given in IS 3716 should be maintained in the sub-stations.

**6.1.1** Where adequate ground clearance cannot be provided in sub-stations, fences, guards, or other means of protection should be provided. In sub-stations and transformer decks, sufficient clearance should be provided for the safe operation of service vehicles without damage to the installed equipment or exposing maintenance and repair men to hazards.

**6.1.2** Barriers in stations, cutting off access to enclosures within the station chambers, cubicles or cells containing high and/or extra high voltage apparatus should normally be kept locked. No person except an authorized person or person acting under his immediate supervision should have access to any enclosure, chamber, cubicle or cell in which a live conductor is exposed.

## **6.2 Overhead Lines**

Ground clearance for over head lines across streets or along streets and other structures should be as given in *Central Electricity Authority (Measures Relating to Safety and Electric Supply) Regulations, 2010*.

## **7 GENERATORS**

**7.1** Insulation of large generators should be of epoxy based resin, mica, glass, thermosetting or any other material which is non combustible, flame retardant and self extinguishing. Fire protection systems with carbon dioxide may not be advisable in underground installations. Use of water spray for fire protection of generators may be considered in such cases.

**7.2** For working on generators, the following procedure should be adopted:

- a) A permit-to-work or sanction should be obtained for all work/test on generators and generator-transformer circuits as per normal clearance procedures given in Annex A.
- b) For isolating and de-energizing generators, the generator main disconnecting switch, the

neutral disconnecting switch, generator potential transformer switches or fuses and switches connecting unit auxiliary transformer should be opened.

- c) Before any work is carried out on the generator windings or on directly coupled generator transformer circuits the generator should be at rest (unless permission has been given by the senior authorized person). Whilst the generator is on run, the field circuit should be opened/isolated and locked out and the inlet-valve controlling supply to the prime mover should be locked in the closed position.
- d) All remote operational controls should be rendered inoperative before taking up any maintenance work.
- e) Before undertaking work in the generator and its enclosure, all its fire protection features should be rendered inoperative.
- f) Metal rods, bars or strips should not be brought near live electromagnets or passed over the energized machine.

## **8 TRANSFORMERS**

All transformers should be fenced or protected to prevent persons coming in contact with terminals or buses. Suitable fencing and curbs should be provided for transformer vaults located in galleries of dams and rooms/buildings, to prevent possible personal contact. Such equipment should be installed out-side a plant building, wherever possible, especially if oil filled transformers are in use. As far as possible, in the case of underground power houses transformers should be located in a separate cavern. If the transformers are installed in the power house, these would normally be in a separate gallery, every transformer should be housed in separate cubicles, formed by fire protection walls. Suitable ducts for removal of foul gases, smoke, and fumes in the event of fire should be provided. Oil soaking pits should be provided for collecting spilled oil. Use of dry type of transformers inside power houses tunnels etc, should be recommended as far as possible, to avoid fire hazards. Adequate clearances as prescribed in 'Indian Electricity Rules' should be provided. A permit to work or sanction for test should be obtained for all work on transformers and proper procedure as laid down in *Central Electricity Authority (Measures Relating to Safety and Electric Supply) Regulations, 2010* shall be followed.

## **9 INSTRUMENT TRANSFORMERS**

**9.1** A permit to work or sanction for test shall be obtained for all works on instrument transformers.

**9.2** Following precautions should also be observed

while working on instrument transformers:

- a) Cases of all instrument transformers shall be earthed.
- b) In handling instrument circuits the secondary circuit of a current transformer shall not be opened while it is alive.
- c) Before any work is carried out on an instrument or other device in a current transformer secondary circuit the device shall be bridged with jumpers, so that the circuit can not be opened at the device. The circuit shall never be opened at meter connections until it has been bridged elsewhere.
- d) Potential transformer (PT) secondaries shall never be short circuited.
- e) Low voltage windings of PTs shall always have one side permanently and effectively earthed.

## 10 GAS INSULATED SWITCHGEAR

**10.1** A permit to work or sanction shall be obtained for all works on gas insulated switchgear.

**10.2** In case gas insulated switchgear has been installed for the generating stations, the following safety precautions should be taken while working on gas insulated switchgear:

- a) The fact that the metal enclosed gas insulated switchgear offers a high degree of safety, shall not lead to the operating personnel showing a certain indifference to the safety rules in the course of time.
- b) The operating personnel shall be familiar with the handling of sulphur hexa fluoride ( $SF_6$ ).
- c) Gas handling, for example filling, evacuation has to be carried out only by qualified personnel. The gas is about 5 times heavier than that of air. Therefore, it collects at the lowest point, for example in the basement, cable ducts, etc, displaces the air and causes risk of suffocation.

**10.3** Following precautions should also be observed while working on GIS:

- a) Before carrying the maintenance, the room should be thoroughly ventilated;
- b) Do not inhale the dust (use dust protection mask), do not let it come into contact with eyes (use gas proof protective glasses) and do not let it come into contact with skin (wear protective clothes);
- c) Any dust on skin should be washed off with plenty of water;

- d) Do not stirrup the dust, remove it with a vacuum cleaner with paper filter (let through < 0.5 percent) or wipe it off with dry cleaning rag;
- e) Treat filters, cleaning bags and other materials so that the trapped dust is not set free again. Do not open filter bags;
- f) Before discarding any equipment, it should be neutralized by immersing in 3 percent soda solution for 24 h, then disposed-off as waste;
- g) Do not eat, drink and smoke in rooms, particularly where switching dust is likely to be present;
- h) Before taking a break and after work, thoroughly clean your face, neck and arms using soap and plenty of water.

## 11 CABLES

**11.1** A permit to work or sanction shall be obtained for all works on cables.

**11.2** Following precautions should also be observed while working on cables:

- a) Before digging, put off the point of fault. The authorized person shall determine the particulars of all cables in the vicinity of the faulty cable.
- b) All cables in the vicinity of fault point shall be exposed and identified to establish the identity of the faulty cables.
- c) Before a high or extra high voltage cable is cut, the authorized person shall make definite checks to identify the cable and to ensure that the cable has been made dead and earthed. He shall then spike the cable in an approved manner at the point where the cut is to be made.
- d) After completion of work the cable shall be properly tagged and its position entered in appropriate place (for example cable identification card).
- e) Employees shall not step on live cables even though they are insulated and enclosed in lead sheath. Tools and material shall not be rested against the sheath of the cables.

## 12 METAL CLAD SWITCH GEAR

**12.1** A permit to work or sanction shall be obtained for all works on metal clad switch gear/ bus bar spouts/ feeder/voltage transfers spouts.

**12.2** Following precautions should be observed while working on Metal Clad Switch Gear:

- a) A permit-to-work or sanction for test shall be

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- obtained for all work on bus bar spouts and feeder and voltage transfers spouts.
- b) The isolating arrangements and the shutters of live spouts shall be locked so that they can not be operated. In the case of bus bar spouts where duplicate switches in one tank or on load bus bar isolators are installed and it is not possible to isolate a bus bar fed from different sources of supply, all the switches that can be closed to the gear involved shall be locked in the open position and the closing mechanism made inoperative.
  - c) Approved indicators shall be used to verify that the circuit is not live and the indicator itself shall be tested before and after use.
  - d) Approved appliances shall be used for earthing. The insertion of hand or any other tool in the bus bar, feeder or transformer spouts for this purpose shall be strictly forbidden.
  - e) Temporary earthing shall be removed from one phase at a time from the point of work.

## **13 ACCESS TO CONTROLS**

Switches and other control devices should be located and arranged so as to be readily accessible for safe operation. Platforms should be built, wherever necessary, to provide access to switches. Adequate space should be provided to operate and service equipment so that unnecessary, uncomfortable or hazardous positions during normal operations are not needed.

## **14 OUTLETS**

Flush type floor level receptacles should be used to obviate tripping hazards. Electrical outlets in all permanent installations, where power tools are used, should be of the type which provide a ground connection for the tool. Tools specified for operation at such installations should also be provided with ground wire and a three-way or four-way plug as the case may be.

## **15 CONDUITS**

Lengthy runs of cable conduits should terminate in such a manner so as to preclude the possibility of water condensing therein and dripping on equipment.

## **16 BUS-BARS**

**16.1** Generator bus leads, terminating in a mesh or screen covered box on the side of a generator, with which personnel frequently come in contact, should be totally enclosed when so situated, and when live parts are within a short distance of such a covering.

**16.2** Buses on main control boards of high potential should be provided with protective guards or insulating tape.

## **17 ASSEMBLY PEDESTALS**

Pedestals for generator rotor assembly and transformer untanking pits should be recessed in floors with removable flush covers, protective guards and hand rails, etc.

## **18 SWITCHES**

Electrical switches controlling moving of dangerous equipment should be equipped with locking devices so they can be locked in the 'open' position.

## **19 STORAGE BATTERIES**

### **19.1 Isolation**

All stationary storage batteries using acid or alkali as electrolyte, consisting of cells connected in series with a nominal voltage of 50 V or more should be installed in separate rooms. The room should be provided with an exhaust fan and running water with a wash basin. Outside the room acid resistant paint should be used to reduce the corrosive effect of acid fumes.

### **19.2 Caution**

Smoking, or the use of open flames, or of tools which may generate sparks, should be avoided except when cells are not actively gassing and when prior ventilation has been ample. Sparks from frictional or static electricity should be avoided as they may ignite the gas, if discharged close to its source, as at the vent of a sealed type cell during overcharging. The electrolyte of storage batteries and spray containing electrolyte are somewhat corrosive, particularly when concentrated by evaporation, and contact with body or clothing should be prevented.

## **20 LIGHTNING ARRESTORS**

**20.1** No work should be done on a lightning arrestor unless it is disconnected from the live circuit and earthed at both the line and ground terminals.

**20.2** Tanks of electrolyte or shields of oxide films of lightning arrestors should never be touched when the arrestors are energized.

**20.3** High voltage and extra high voltage lightning arrestors, where accessible, should be provided with suitable screens or fences against possible contact while the arrestors are alive. The gate of the screens should be kept locked and the key should be with the operator on duty.

## **21 FIRE PREVENTION AND FIRE FIGHTING**

**21.1** The details of construction and provision of fire

extinguishing systems and fire fighting equipments should be according to IS 10386 (Part 7).

**21.2** The provision of water supply should be made according to IS 9668 and external hydrants should be according to the provisions of IS 13039.

**21.3** Periodic training classes should be held to ensure that all regular employees are familiar with the following:

- a) Common fire hazards, techniques of fire prevention and fire fighting;
- b) Use of various types of fire safety equipment;
- c) Location of exits and fire fighting equipment;
- d) Precautions against electric shock and inhalation of toxic gases; and
- e) Operations to be carried out in case of fire involving electrical equipment, or in the vicinity thereof.

**21.4** Precautions to prevent common types of electrical equipment fires are briefly given below:

- a) Electrical equipment should be installed, operated and maintained properly and in a manner so as to eliminate sparks due to poor contacts in switches and fittings, worn out insulation, crossed wires, opening of switches carrying large currents, etc.
- b) Metal parts of oil tanks, electrical equipment and buildings 'etc' should be adequately bonded and grounded to prevent fires by lightning and static electricity.
- c) Flammable gases or materials should not be stored near electrical equipment.
- d) Electrical lamps should not be surrounded by or laid on, combustible materials.

**21.4.1** Motors should be equipped with over current and under voltage protection to prevent excessive heating.

**21.4.2** Battery rooms should have no loose connections and there should be no sparking devices, for example bells, buzzers, relays, fuses or switches in the room. Smoking should be prohibited and rubbish and other combustibles should not be allowed to accumulate in battery rooms and near electrical plants and machinery.

**21.4.3** Type of fires and the equipment to be used for extinguishing them are given in IS 2190.

## 22 PUMPING PLANTS

**22.1** In case of power stations provision of suitable and reliable drainage and dewatering pumps of adequate capacity (it is advisable to provide 100 percent spare pumping capacity) capable of running under the

most adverse conditions should be made. Discharge pipes from equipment to be drained should be directly connected to headers going to the sump. Capacity of sump and pump should be adequate to ensure reliability of operation. Power supply to the pumps should be reliable and to achieve this, pumps should be supplied from at least two power sources employing a carefully designed interlocking scheme. The control panel for drainage and dewatering pumps should be located at higher elevations to avoid flooding. Water proof cables should be used for submersible pumps.

**22.2** Pumping plants can be dangerous because of the electrical equipment installed there. In order to protect persons from getting hurt, it is good practice to place fences around all unhouse pumping plants. These fences also serve to protect the installed equipment from being tampered with. The protection of persons from hazards of open hatches, slippery floors, trash rack decks and other danger spots also needs to be kept in view and appropriate measures taken.

## 23 POWER DRIVEN MACHINERY

**23.1** As used herein, this classification includes wood working machinery such as a bench saws, jointers, band saws, jig saws and lathes; metal working machinery such as lathes, punch presses, drill shapers, drilling machines, milling machines and grinding wheels; and other similar machinery.

**23.2** All electrically driven machinery and portable tools should be provided with special insulated power transmission cables having water proof connections, and should have three wire extensions and three-way plugs and outlets, one of which connects the non-current carrying parts of the motors and the frame to the ground. Tools provided with two-way outlets should also be grounded. Where stationery machinery such as bench saws, jointers and drill presses are driven by individual motors, the motors and frames should like wise be grounded.

**23.3** If required electrical equipment operating on 110 V or 24 V may be used with measures as decided by the engineer in charge.

## 24 CRANES AND HOISTS

**24.1** All cranes and hoists should have a minimum safety factor of 5, and should never be used to handle loads in excess of their designed capacity. They should be equipped with proper safety devices and braking equipment, which should be capable of effectively braking a weight at least one and one and a half times the full rated load. Provisions should be made in the design, so that loads of all types can be lowered with the power on and the motor in gear.

**24.2** Capacity name plate should be attached to all cranes and hoists and should clearly indicate the safe load in tonnes.

**24.3** The design should provide for sufficient number of full ways of cable on the drums of cranes and hoists.

**24.4** Electrical controls and switches should be placed in access ways to remote-controlled elevated cranes to ensure that the crane busbar, etc, are de-energized before the equipment can be reached for servicing. It is recommended that each controller in an overhead traveling crane cab, or cage, be equipped with a mechanical lockout suitable to hold a padlock. Design specifications should also contain provisions for clearly labelling or marking all electrical switches and controls. Limit switches and automatic power shutoffs should be provided in the design for all bridge cranes.

**24.5** All elevators, hoists and lifts should be designed with safety devices to prevent dropping of cages or loads, in case of equipment or power failure, and the entrances to shafts should be guarded by gates or doors that are closed and locked automatically when the car or cage leaves a floor. Elevator escape hatches should be designed for easy removal. The outside, stationary door on each floor of the elevator shaft should be so designed that it may be opened manually from inside the shaft, in the event of the elevator being stalled between floors.

## **25 FIRST AID AND RESUSCITATION**

**25.1** The contractor for the works under his contract and project authorities should provide the following:

- a) Adequate first aid arrangements at various places of work.
- b) First aid kits to the working parties.
- c) Arrangement and incentives for training in rendering of first aid to its employees.
- d) Instructional charts for artificial respiration and other first aid should be displayed at conspicuous places. Telephone numbers of nearest Doctor/Ambulance service should also be prominently displayed.

**25.2** First aid personnel should cultivate a methodical, regular and natural approach to be able to render skilled assistance. The guidelines given below should also be kept in mind:

- a) Remove the patient from the source of injury viz electric conductor, water, moving machinery, etc.
- b) Where patient is in contact with a live conductor or equipment, switch off current at once before removal of the patient. If this cannot be done and the patient is in contact

with low voltage apparatus, pull him off by using rubber gloves, if handy, or by his coat or shirt, or any dry cloth, bag, newspaper or dry rope. If the patient is in contact with high voltage apparatus, he should be handled only with a high voltage operating rod or a piece of perfectly dry wood or rope, care being taken to have at least 1 m of wood or rope between the hands of the man and any live metal.

- c) In case of electric shock extinguish sparks, if any, and if breathing has stopped, begin artificial respiration without delay, even if the person appears to be dead. The doctor should be called immediately.

## **26 LIGHTING IN THE POWER HOUSE**

**26.1** In addition to normal lighting in the power house emergency lighting from d.c. storage batteries should also be provided. Sufficient provision should be made in the capacity of the battery on this account so that whenever station a.c. supply for lighting fails, d.c. lighting supply is automatically switched on and continuous lighting is maintained in the power house. Portable dry or rechargeable battery operated lamps for emergency use may also be used where necessary.

**26.2** Use of fluorescent lamps is preferred due to their high efficiency. Protective guards around all lighting points in the vicinity of likely working zones is also essential.

## **27 VENTILATION**

**27.1** All underground locations where electrical apparatus is installed, various buildings and enclosures, should be adequately ventilated to ensure adequate number of air changes as prescribed in the relevant standards.

**27.2** Ventilation may be forced or induced by fans, etc.

## **28 PREVENTIVE MEASURES AGAINST EARTHQUAKES**

**28.1** All electrical plant and equipment should be designed according to relevant Indian Standards to withstand earthquake intensity of the project site. Anchor bolts for moving equipment such as transformers and cranes, etc, should be provided with a clamping arrangement to avoid accidental movement.

**28.2** As a prevention against damage to the civil structures and electrical installations, designs should be comprehensive after taking into account the maximum probability and intensity of earthquakes in the area. In this connection relevant Indian Standards may be consulted.

## 29 EMERGENCY POWER SUPPLY

Arrangements of power supply for essential services such as dewatering, operation of head gates, illumination and ventilation of important and hazardous areas, etc, should have adequate alternative stand by power sources such as diesel/fossil fuel operated generating sets, etc.

## 30 WORKSHOP MACHINERY AND WELDING

**30.1** All electrical machines like lathes and drilling machines should be properly provided with guards to avoid any accidents.

**30.2** Field machinery, like stone crushers, employing belt transmission systems should be provided with protective guards.

**30.3** Extensive welding is done in projects. Suitable safety appliances like goggles, hand gloves, etc, should be used by the welders. Welding accessories like cutting torches, cables, nozzles, etc, should be inspected periodically and kept in good condition.

## 31 PREVENTIVE MEASURES DURING WORK INSIDE UNDERGROUND STRUCTURES

**31.1** No person shall enter or be permitted to enter any underground chamber or other confined space in which dangerous fumes are likely to be present, unless,

- a) it is provided with a man hole of adequate size or other effective means of egress;
- b) a certificate in writing has been given by a competent person based on a test carried out by himself, that the space is free from dangerous fumes and fit for persons to enter; or
- c) while work is being performed in manholes or vaults, a person must be available in the immediate vicinity to render emergency assistance, if required. It shall also be ensured that the employee is wearing a suitable breathing apparatus and a belt, which is securely attached to a rope, the free end of which is held by the person in the immediate vicinity.

**31.2** Open flames and smoking shall be avoided in underground chambers.

**31.3** For work inside the underground structures, special attention shall be given to general safety rules, familiarity with the cable and equipment being worked on, and rules applying to such underground work.

### 31.3.1 General Safety

All work shall be done with the following precautions:

- a) Continuous adequate ventilation should be provided.

- b) A ladder should always be used when entering or leaving a manhole or vault. Climbing into or out of manholes or vaults by stepping on cables or cable supports shall be forbidden. Manhole ladders, when not in use, shall be placed as not to be a hazard to workers, pedestrians, or vehicular traffic. Hard hats should be used when entering or working in manholes.
- c) Tool handling should be done in a manner that protects the workers and work area.
- d) Tools or materials should always be placed at a safe distance from manhole openings, where they will not cause a stumbling hazard or come in contact with energized conductors or equipment.
- e) Tools or materials should not be thrown into or out of manholes. Canvas buckets or hand lines should be used for lowering tools or equipment into and removing them from manholes. Workers should be warned before lowering tools.
- f) Before starting work, an inspection should be made to determine, if there are any dangerous conditions such as burnt or cut cables or loose or defective ladders. Use of portable ladders should be preferred. Ladders in manholes, if provided, may have rusted and become unsafe. Before using open flames in manholes or excavations where combustible gases or liquids may be present, the atmosphere shall be again re-tested and found safe or cleared of the combustible gases or liquids. When open flames have to be used in manholes, extra precautions shall be taken to provide adequate ventilation.
- g) Flashlights or facility with approved lighting units should only be used for illumination in manholes.
- h) Low voltage equipment is especially hazardous in or around subsurface structures. Motor frames and equipment cases may be energized by electrical conductors with frayed or damaged insulation. The faults may occur only momentarily or may be prolonged through high-resistance grounding paths. Contact with energized equipment surfaces and the damp and well-grounded floors and walls often results in electrocution. So, only pneumatic tools and low-voltage (24 V) lighting systems should be used in maintaining subsurface vaults and facilities.

### 31.3.2 Precautions Before Commencing Work

- a) The worker should be familiar with the system

- and then proceed to any necessary tagging of cable and equipment.
- b) Every possible precaution should be exercised to correctly identify voltage, circuit, and phase of cable or apparatus to be worked upon.
  - c) The external appearance of medium-voltage and low-voltage cables is often similar. For this reason, a very careful check should be made of duct/manholes locations and tag numbers before starting work. Any errors found in the tagging of cables or in the records of manholes or maps should be immediately reported to the supervisor. Under no circumstances should an identification tag be removed or placed on a circuit without direct permission from the supervisor.

### **31.3.3 Requirements for De-energized Work Safe Clearance Procedures**

- a) Where cables are being de-energized to be worked on, all instructions pertaining to the clearing of circuits, tagging, and grounding shall be complied with.
- b) Standard practice for cable work is to provide complete isolation of cable and protection against premature energizing. An absolute check to ensure that no potential exists shall be made prior to cutting into any cable. The cable (lead or other) sheathing should be removed and tested for voltage. Approved voltage detectors should only be used.
- c) Working on cable and equipment should normally be done after de-energizing the cable or apparatus to be worked on.

### **31.3.4 Checks for De-energization**

The cable or apparatus shall be considered energized and worked with adequate protective devices until the following steps have been taken:

- a) The item has been tested with an approved device and proven to be de-energized.
- b) The item has been grounded from all possible sources of power (including transformer secondary backfeeds).
- c) The item has been proved de-energized at the work location. The ground connection may be removed for test purposes with the approval of the supervisor in charge after the circuit has been tested and proven to be de-energized. The removal of ground connection should only be permitted, if their application increases the work hazard.
- d) Before working on any section of cable or apparatus to which cable is connected, care

shall be taken to ensure that the cable has been grounded for a sufficient length of time to drain off any static charges.

- e) Heating materials and equipment used in splicing cable should be heated in such a manner as to prevent any hazard to those working in manholes or vaults including the persons and vehicles around.

### **31.3.5 Hazard Elimination**

The following precautions should be observed to protect the personnel and the workplace:

- a) Gloves should be worn while heating or working with hot insulating compound.
- b) The cylinders containing liquefied petroleum gas, such as butane or propane, should not be placed in a manhole or vault.

### **31.3.6 Lighting**

Adequate lighting shall be provided at the face and at any other point where work is in progress, at equipment installations.

Emergency lights (battery operated) shall be installed at the working faces and at intervals along the tunnel to help escape of workmen in case of accidents. All supervisors and gang-mates shall be provided with cap lamps or hand torches.

Voltage for lighting in the underground works should be as specified for underground lighting as per *Central Electricity Authority (Measures Relating to Safety and Electric Supply) Regulations, 2010*.

## **32 GENERAL SAFETY PRECAUTIONS**

The following safety precautions should be observed:

- a) All electric apparatus shall be considered as live unless it is checked and confirmed.
- b) No person should touch the insulation, which covers or supports any conductor subject to extra high or high voltage, unless the conductor is dead and earthed.
- c) The spaces adjacent to exposed live equipment shall not be used as passage ways.
- d) In places where there are possibilities of explosion from flammable gas or vapour mixture, all electrical apparatus shall be so constructed so as to exclude such dangerous items from the area of risk.
- e) Electrical conductors, cable, etc, shall as far as practicable be so arranged that their route can easily be traced.
- f) Pliers, screwdrivers, fuse pullers and similar hand tools used in connection with electric

- work shall be adequately insulated.
- g) Handles of oil cans and of wipers, brushes and other cleaning devices used around electrical equipment shall be made of non-conducting materials.
  - h) Electrical circuit and other electrical equipment shall be identified by labels or other suitable means to reduce the risk of accidents from mistakes.

### **33 PRECAUTIONS DURING OIL AND SULPHUR HEXAFLUORIDE ( $SF_6$ ) HANDLING**

**33.1** During oil handling operations on oil-filled equipment, following precautions should be observed to prevent the build up of a hazardous electrical charge:

- a) The apparatus tanks, conductive hoses, pumping or filtering equipment, drums, trucks and portable storage tanks should be grounded to the station ground mat. The vehicle end should be connected first and disconnected last to prevent possible arcs near the vehicle. Conductive hoses should be tested for continuity before use.
- b) The exposed conductors should be grounded, such as transformer or circuit breaker bushings, or coil ends of transformers where bushings have been physically removed, to the same grounding point.

**33.2** Sulphur hexafluoride ( $SF_6$ ) equipment should be grounded in accordance with manufacturer's recommendations.

### **34 PRECAUTIONS DURING OPENING OR SPLICING DE-ENERGIZED CONDUCTORS OR OVERHEAD GROUND WIRES (OGW)**

Before separating and/or splicing a conductor or OGW (while under a clearance), the following precautions should be taken:

- a) All conductors should be bonded together, including OGWS when applicable, and these should be bonded to the ground as near to the worksite as practicable.
- b) A ground should be installed for the damaged conductor or OGW at each structure from which it is to be lowered. Continuous grounding shall be in place until the conductor or OGW is reinstalled.
- c) A ground rod and ground cables should be installed and bonded to the metallic work platform if one is used. A ground rod (using a hotstick) should also be installed to each side of conductor where the conductor or OGW is to be cut or spliced.

NOTE — If an insulated work platform is used, it must be kept clean and dry.

## **ANNEX A**

*(Clause 7.2 )*

### **CLEARANCE PROCEDURE**

#### **A-1 GENERAL PROVISIONS**

**A-1.1** The clearance procedure is intended to meet the following principal requirements in relation to potentially dangerous jobs:

- a) Protection of men at work;
- b) Protection of equipment; and
- c) Designation of abnormal conditions.

**A-1.2** The requirements given in **A-1.1** are to be achieved by providing safe working conditions, essential information and guidance to the men at work, checking arrangements to ensure reliability of the highest order, etc, through the use of the following:

- a) Permit-to-work;
- b) Sanction for test;

- c) Station guarantee;
- d) Self-protection tag; and
- e) Danger notices.

**A-1.3** Clearance procedure is equally applicable to electrical and mechanical processes.

**A-1.4** The undertaking should issue instructions for,

- a) making applicable such portions of the provisions of this section as apply to their work;
- b) appointment of senior authorized person(s) for controlling the issue and cancellation of clearances under various conditions and safe and expeditious execution of work there under, their relations with 'power controllers', etc;

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- c) appointment of authorized person(s) for work on various types of jobs; and
- d) copies of these instructions should be displayed in the office of the senior authorized person, control room and appended to this code, in so far as may be required for reference of the persons concerned.

**A-1.5** For switching operations on electrical apparatus the following conditions should be observed:

- a) Switches used in isolating apparatus for giving clearance should have contacts that are visible or the positions of which can be positively determined by inspection. All phases of such switches, irrespective of the type, should be inspected to make sure that they all open;
- b) If electrically operated or remote mechanically operated switches are used, they should be locked or blocked open or a portion of the mechanism should be removed to prevent accidental closure;
- c) Switching operations in unattended stations and line sectionalizing points for purposes of clearance should be done by persons specifically authorized for this purpose; and
- d) Particulars of all switching operations and transactions connected therewith should be recorded in the station log or the registers maintained for this purpose.

**A-1.6** Persons issuing clearance should ensure that,

- a) clearance is issued only for the actual work on electrical apparatus or mechanical equipment.
- b) clearance is issued in the name of the persons under whose supervision the work is intended to be carried out. In case the nature of the work requires personal supervision of the senior authorized person, a clearance be issued by him only.
- c) before issuing a clearance, the electrical apparatus or mechanical equipment, as the case may be, is made entirely safe for working and danger notices are attached at appropriate places and in a conspicuous manner.
- d) the person taking clearance understands the particulars of the work to be done as well as particulars of the operations carried out (including those of earthing arrangements) to make the working safe and the extent of the area safe for working.
- e) the electrical apparatus or mechanical equipment covered by the clearance has been duly surrendered and cancelled.

- f) particulars of clearance ( for example type, serial No., time of issue and cancellation ) are recorded in the station log or a register to be kept for this purpose.
- g) before going off duty they formally handover records relating to clearances issued by them, indicating clearly the clearances remaining unsurrendered. The senior authorized person and the operator taking over should correspondingly acknowledge the records and the information as above and make sure that they have a clear understanding of the situation in each case.

**A-1.7** Person taking clearance should ensure that,

- a) all electrical apparatus are treated alive by the persons under his charge until a specific clearance has been issued;
- b) the area covered by the clearance is made safe for working and proper danger notices have been placed on switches and/or the controlling points concerned;
- c) where a possibility of hazard exists in the vicinity of the work site, the boundaries of the area safe for working are clearly marked and persons other than the members of the working party or those specifically authorized by the Senior Authorized Person are not allowed to enter hazardous positions of the work site;
- d) all persons under his control who are to work on the electrical apparatus or mechanical equipment covered by the clearance, understand the extent of the area safe for working;
- e) in cases where the work involves hazards in the vicinity of the work site, one of the members of his party to be appointed as a safety man and it should be his duty to maintain a continuous watch over the workmen and to issue warnings of any unsafe conditions which he observes;
- f) before starting work the person in charge of the working party should check, in the presence of another person, by means of approved devices or visual inspection whether the line or equipment concerned is de-energised and effectively earthed;
- g) the safety measures, as above, continue to be in force until the work is completed or suspended ( for example earthing arrangements should not be removed );
- h) on completion of the work the ( 1 ) material, tools, etc, and ( 2 ) persons under his control are immediately removed and made clear of

- the equipment under clearance;
- j) the clearance is surrendered for cancellation to the issuing officer immediately after the action referred to under ( h ) is completed;
- k) where any changes which may affect the operation of the equipment or the line have been made, this should be clearly brought to the notice of the officer issuing the clearance while surrendering the clearance;
- m) if due to any circumstances the clearance cannot be surrendered by its holder within the period originally estimated, the fact should be immediately brought to the notice of the officer issuing the clearance; and
- n) where possible the person surrendering the clearance should initial the log entry.

## A-2 PERMIT-TO-WORK

**A-2.1** Permit-to-work is a means to make known to persons undertaking construction, repair or maintenance jobs exactly what electrical apparatus or mechanical equipment have been made safe to work on, description of the job, special precautions, if any, for safety of workmen on the job, etc. It ensures safe working conditions until it is surrendered. For forms showing permit-to-work on electrical apparatus or mechanical equipment 'The Model Code for Safe Operation and Maintenance of Generating Stations' of Central Electricity Board should be referred to.

**A-2.2** No construction, repair or maintenance work on, or in the proximity of high tension or extra high tension apparatus or mechanical equipment where technical knowledge or experience is required to avoid danger, should be carried out unless a permit-to-work on the prescribed forms has been issued by the senior authorized person to the authorized person.

**A-2.3** In cases, where the work is to be carried out on major units of plant and equipment, or the work requires extraordinary care in supervision of the work, the permit should be used with the approval of the station superintendent, and in cases where the station superintendent is the senior authorized person himself, the permit should be issued with the approval of the Engineer-in-Charge of the undertaking.

**A-2.3.1** The person issuing a permit-to-work should ensure that the apparatus/ equipment is made perfectly safe to work on as follows:

- a) In the case of electrical apparatus the isolation is complete, the metal parts are adequately earthed and caution notices are attached at appropriate places;
- b) In the case of mechanical equipment, the isolation is complete and condition rendered safe ( for example by opening proper valves, gates, etc, to reduce the equipment to atmospheric pressure; removal of poisonous, suffocating or explosive gases; application of brakes and blocks; allowing temperature to come down; as the case may be ), and caution notices are attached at appropriate places; and
- c) Maintenance of the above conditions is essential until the permit is surrendered and cancelled.

**A-2.4** Permits should be prepared in duplicate. The first copy of the permit should be handed over to the person-in-charge of the work (also known as permit holder) and the second copy should be retained by, or forwarded to, the operator or any other person-in-charge of operations. Permit books should be treated as important records. The sheets and the books themselves should be serially numbered. No page should be detached or used for any but bonafide work. If any paper is inadvertently detached, a dated and initialed statement should be placed there and then recorded in the book by the person concerned.

**A-2.5** The permit holder should be responsible for identifying the isolated and de-energized circuits in the case of work on multi-circuit lines or on single circuit lines situated close together.

**A-2.6** After surrender of the permit to the person issuing the permit, the original copy, duly completed should be forwarded by him to the station superintendent for information and record and the second copy should be retained in the records of the senior authorized person. Provided, where the station superintendent is the senior authorized person himself, the original copy should be forwarded to the Engineer-in-charge of the undertaking.

**ANNEX B**  
**(Foreword)**  
**COMMITTEE COMPOSITION**

Safety in Construction, Operation and Maintenance of River Valley  
 Projects Sectional Committee, WRD 21

<i>Organization</i>	<i>Representative(s)</i>
NTPC Ltd, New Delhi	SHRI V. K. GUPTA ( <b>Chairman</b> )
Bhakra Beas Management Board, Chandigarh	MEMBER (IRRIGATION) DIRECTOR (DAM SAFETY) ( <i>Alternate</i> )
Central Board of Irrigation & Power, New Delhi	SHRI A. C. GUPTA SHRI M. L. BAWEJA ( <i>Alternate</i> )
Central Electricity Authority, New Delhi	SHRI MANOJ SIKDAR SHRI MANOJ TRIPATHI ( <i>Alternate</i> )
Central Water Commission, New Delhi	DIRECTOR (DSM) DIRECTOR (DSR) ( <i>Alternate</i> )
Geological Survey of India, Kolkata	SHRI D. N. BHATTACHARYA SHRI C. PAUL ( <i>Alternate</i> )
Indian Institute of Technology, Roorkee	DR GOPAL CHAUHAN (WRDM)
Irrigation & CAD Department, Government of Andhra Pradesh, Hyderabad	SHRI I. S. N. RAJU SHRI S. PANDURANGA RAO ( <i>Alternate</i> )
Irrigation Department, Government of Punjab, Chandigarh	CHIEF ENGINER (RSDD) DIRECTOR DAMS (RSDD) ( <i>Alternate</i> )
Irrigation Department, Government of Maharashtra, Nashik	SUPERINTENDING ENGINEER (DSO) Executive Engineer (DSO) ( <i>Alternate</i> )
Irrigation Department, Government of Uttarakhand, Dehra Dun	CHIEF ENGINEER (GANGA VALLEY) SUPERINTENDING ENGINEER (MB DAM) ( <i>Alternate</i> )
NHPC Ltd, Faridabad	SHRI A. K. JAIN SHRI KAJAL SAHA ( <i>Alternate</i> )
National Projects Construction Corporation Limited, Faridabad	SHRI S. BASAK SHRI A. K. GUPTA ( <i>Alternate</i> )
North Eastern Electric Power Corporation Ltd, Shillong	SHRI A. C. BORAH SHRI K. G. MITTAL ( <i>Alternate</i> )
NTPC Ltd, Noida	SHRI G. L. HURIA
Saradar Sarovar Narmada Nigam Ltd, Gandhi Nagar	EXECUTIVE DIRECTOR (D&P)
Satluj Jal Vidyut Nigam, Shimla	SHRI R. K. SHARMA SHRI V. S. ( <i>Alternate</i> )
Tamil Nadu Electricity Board, Chennai	SHRI K. GOPAL SHRI V. GOPALAKRISHNAN ( <i>Alternate</i> )
THDC India Ltd, Rishikesh	SHRI R. K. VISHNOI SHRI MANOJ SARDANA ( <i>Alternate</i> )
Water Resources Department, Government of Madhya Pradesh, Bhopal	DIRECTOR (DAM SAFETY) SHRI R. K. JAIN ( <i>Alternate</i> )
In personal capacity [ <i>Institution of Fire Engineers (India), Genmala High School Road, Venmala 682028, Cochin</i> ]	SHRI G. B. MENON
BIS Directorate General	SHRI J. C. ARORA, Scientist 'F' & Head (WRD) [Representing Director General ( <i>Ex-officio</i> )]

*Member Secretary*  
 DR R. R. DASH  
 Scientist 'C' (WRD), BIS

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